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Abstract

The concept of ‘smart living’ is becoming increasingly prevalent in discussions about anticipated energy futures. However, despite the promises surrounding smart technology, take-up to-date has been relatively low, with existing research showing that concerns about it abound. Smart technology has also been positioned as potentially able to alleviate fuel poverty, yet there has been little exploration of how it is perceived and experienced by vulnerable consumers. In this paper we situate these discussions in the context of interview data with residents in a Welsh Valleys community where smart technologies were due to be installed in some homes as part of a wider energy scheme. Whilst there was some enthusiasm for aspects of smart technology, participants often found it difficult to see how it would improve their everyday lives and energy use, expressing scepticism and concern that energy consumption would be increased. In exploring these issues, we raise questions for the smart energy agenda and supporting policy, highlighting the need to account for people’s different abilities and enthusiasm to relate to smart developments in everyday energy technologies. In particular, we argue for the importance of considering vulnerable consumers in smart transitions, to avoid worsening already precarious positions.

Highlights

- Qualitative longitudinal study involving vulnerable consumers
- Exploration of how vulnerable consumers view smart technology
- Qualitative data insights related to policy claims that smart meters could alleviate fuel poverty
- Policy implications concerning resistance to smart technology

Keywords

Qualitative longitudinal, Smart technology, Vulnerable consumers

1. Introduction

In this paper we consider perceptions and experiences of smart technology amongst low-income householders, drawing on qualitative longitudinal data from a Welsh Valleys community case site. In foregrounding these accounts, we explore how vulnerable consumers relate to smart technology and claims that it could help to alleviate fuel poverty, drawing out implications for energy policy in this area. We begin with a discussion of existing literature on smart, with particular consideration of how this relates to vulnerable consumers.

In her book on the smart utopia, Strengers (2013:1) describes smart as follows:

‘In its broadest sense, ‘smart’ represents an ultimate desired state across all aspects of contemporary life. It encapsulates ideals of efficiency, security and utilitarian control in a technologically mediated and enabled environment. Further, it is employed by its proponents as a means of imagining and realising social and technological progress, while simultaneously solving a range of social and environmental problems.’

The utopian vision of smart that Strengers critiques implies an increased reliance on technology, which extends to people becoming smart citizens, users or consumers of smart technologies, with an element of control seen as crucial. Whilst some of these technologies are in relative infancy, others are already a more established part of everyday life for many (for example smart technology includes devices such as thermostats, wireless speakers or home monitoring systems). Despite frequent use, ‘smart’ can be difficult to define in more specific terms than Strengers delineates. In this paper, we understand smart as an ideal of information provision, increased automation and control, whilst smart technology refers to devices that can be remotely controlled and accessed, and respond to the needs of users. Such devices may be combined to create ‘smart homes’, a term which Wilson et al., (2017) use as a generic descriptor for the introduction of enhanced monitoring and control functionality into homes.

Much of the social science research into smart technology has focused on smart meters, which provide digital readings of gas and electricity consumption that can be sent directly to energy suppliers, removing the need to take meter readings. Smart meters also generally have in-home displays that show energy consumption and can reflect cost¹. Expected benefits of smart metering for consumers include increased convenience and reduced cost through more accurate and immediate feedback on energy use. However, smart metering has been developed by energy suppliers as a tool for load management/peak reduction and reducing the cost of customer service, rather than direct consumer benefit (Darby, 2008). There are growing reports of backlashes against smart meters from customers in a number of countries (Wilson et al., 2017), for reasons ranging from perceived invasion of privacy to perceived increases in bills due to the meters and resentment at having to pay for an unwelcome new piece of equipment (Darby, 2010). The hypocrisy of energy-consuming devices that purport to help people save energy has also been commented on by users (Hargreaves et al., 2013). In addition, some have questioned how ‘smart’ some smart meters are, given just making data visible is not seen as helpful (Energy Saving Trust, 2015). Therefore, despite widespread UK Government efforts to promote and roll-out smart meters, the technology appears to remain contentious, with obstacles and delays restricting implementation (Sovacool et al., 2017). Whilst the smart meter is one element, it is often seen as a precursor to other smart technology (see Ballo, 2015 for discussion of smart grids, for example), which makes it important to consider.

1.1 The promises of smart

Strengers’ definition encompasses many of the facets of ‘smart living’², the advantages of which are upheld in numerous policy documents, which frequently refer to the ability of smart to empower consumers (e.g. OFGEM, 2017a; DECC 2015). For example, the UK Government expects that the roll-out of smart electricity and gas meters will deliver a range of benefits to householders, in particular assisting them to understand and reduce

¹ <https://www.smartenergygb.org/en/about-smart-meters/what-is-a-smart-meter>

² ‘This includes the development of new products, technologies and processes which smarten our use of energy, turn our buildings into powerhouses, create local energy micro grids and demonstrate how low-carbon vehicles and integrated multi vector (power, heat and transport) options can achieve a competitive, comfortable and low-carbon ‘smart living’ future for us all’ (Welsh Government 2016:2).

their energy usage, receive accurate bills and switch between suppliers more easily (Smart Metering Implementation Programme, 2018). This empowerment is largely expected to derive from the more accurate picture of domestic energy use that smart meters are intended to provide, with this awareness enabling people to alter energy use in order to make financial savings. However, existing research has critiqued the idea that people behave solely as rational actors responding in a simplistic way to price (Cherry et al., 2017), or that providing data to consumers necessarily translates to rational choice (Strengers, 2013; Throndsen and Ryghaug, 2015), while notions of habit and routine have been drawn on as alternative explanations for action (see Southerton, 2012 for discussion), alongside a body of work from social practice theory that points to the durability of social practices (Shove et al., 2012). Previous research has indicated that technology developers see automation, in the sense of little or no interaction with energy equipment, as being in the interest of consumers (Hansen and Borup, 2018). Such findings reflect a recurrent theme regarding expert views of public attitudes and responses as subject to knowledge deficits regarding technology and science, which leads them to see public attitudes as a problem to be defeated (Skjølsvold, and Lindkvist, 2015). However, the success or failure of domestic smart technologies depends fundamentally on whether and how they are used by householders (Hargreaves et al., 2018) and ordinary people are not necessarily as uninterested and unengaged in their energy consumption as developers tend to think (Schick and Winthereik, 2013).

A central promise of smart technology is that of greater control over functions for the user through more information. However, in relation to smart devices, what ‘control’ means is complex. Hargreaves et al., (2016) argue that control is a critically important concept inside smart homes that deserves further attention. Households often comprise multiple members who may have different views on how energy should be used. Therefore, new technology can redistribute control within households, towards the person who best understands new controls or most wants to operate household equipment (Gram-Hanssen and Darby, 2018). Research based on a field trial of households living with smart home systems found evidence that these systems concentrated control in one person’s hands and, in so doing, often excluded others within the home from simple or

direct control over devices (Hargreaves et al., 2015). It is also possible that smart devices could give rise to increased surveillance of electricity consumption, affecting the control situations within families (Hansen and Hauge, 2017) and concentrating control in and over homes in certain hands and not others (Nicholls et al., 2020). Hargreaves et al., (2016) consider these issues as part of what they have termed ‘relational control’ (householders control over domestic lives and relationships) as part of their argument for a more nuanced understanding of control in relation to smart technology. Consuming electricity is a collective endeavour, meaning energy monitors such as smart meters could give rise to conflicts when different logics of home are weighed against each other (Skjølsvold et al., 2017), or alternatively create non-users by being overly complex (Hargreaves et al., 2018). Beyond the household level, scepticism abounds about the balance of control between the individual and the energy provider. Studies have indicated that ceding autonomy and independence for increased technological control are the main perceived risks of smart technology in the home (Wilson et al., 2017), with reservations around loss of control expressed across a range of social groups (Balta-Ozkan et al., 2013). However, the ability to override could make automation more palatable (Parkhill et al., 2013). Media stories with claims of smart technologies listening in and recording or ‘spying’ on householders (e.g. ITV, March 2017; Independent, October 2017), also highlight concerns about unauthorised access to personal data (Ballo, 2015), with privacy concerns impacting on the take-up of smart meters (Hodges et al., 2018). Issues around control therefore remain pertinent.

Moving beyond smart metering to explore acceptability of other smart home technologies, Balta-Ozkan et al, (2013) found that smart home technology was seen as having the potential to increase leisure time, save money, make life easier, and provide support for assisted living as participants grew older (see also Pragnell et al., 2000). In relation to wellbeing and smart living, digital care services appear to be a significant area of development, although concerns have been raised about the way they could shift responsibility from care providers to individuals (Lupton, 2018). An assisted-living smart home might provide an elderly or disabled occupant and their friends and relatives with greater independence and peace of mind (Balta-Ozkan et al., 2013), potentially affording

people the opportunity to remain in their own homes for longer and avoiding care costs. Existing research found that younger people were much more likely than older people to be positive about the prospect of new technology in the home, whilst the latter were among those most concerned about potential technical problems (Pragnell et al., 2000). Older people are also less likely to be computer literate and therefore could feel excluded by technology (Balta-Ozkan et al., 2013) or lack skills and confidence in dealing with smart technology, which could lead to fear over its use (Brown and Markusson, 2019). However, it is important to recognise that, rather than an issue of access and availability, it may be an active choice for older adults to eschew technology (Knowles and Hanson, 2018). Existing research on smart energy monitors has also illustrated how they might not be particularly useful for older adults, who already felt aware of their energy use and energy saving practices and therefore saw the monitors as providing little new information (Brown and Markusson, 2019). This finding suggests that there is potential for smart technology to exacerbate existing generational (and possibly other) divides.

The term ‘smart’ is associated with meanings such as cleverness and neatness (Gram-Hansen and Darby, 2018), which could be seen as positioning those who do not engage with the smart agenda as ‘dumb’, ‘stupid’ or ‘unfashionable’ to use some common antonyms. Yet, alongside personal choice not to have a home increasingly reliant on technology, it is important to acknowledge that people possess different abilities and resources to engage with smart technology. Given that disadvantaged social groups have limited means (including financial, physical or educational) to interact with these systems, there have been calls for this dynamic to be analysed further (Balta-Ozkan et al., 2013; Energy Saving Trust, 2015). Whilst many technological advances may first be taken up by those often described as early adopters, it has also been suggested that smart technology could aid disadvantaged consumers. For example, the Welsh Government (2019) explicitly states that smart meters have the potential to help those living in fuel poverty^{3,4}, a condition which currently affects 12% households in Wales.

3 <http://gov.wales/topics/environmentcountryside/energy/fuelpoverty/?lang=en>

4 In Wales, households spending more than 10% of income on energy are considered to be in fuel poverty

1.2 Smart technology and vulnerable consumers

Despite claims that smart technology might help to address fuel poverty, or improve the wellbeing of vulnerable consumers (OFGEM, 2018) there has been relatively little empirical work in this area. In particular, for people who are careful in their habits, feedback alone is unlikely to be effective as there may be little opportunity to reduce energy consumption further (Darby, 2010; Hodges et al., 2016, 2018). OFGEM (2017b) define vulnerability as occurring when a consumer's personal circumstances and characteristics combine with aspects of the market to create situations where he or she is: significantly less able than a typical consumer to protect or represent his or her interests in the energy market; and/or significantly more likely than a typical consumer to suffer detriment. Other definitions include households in which consumers are elderly, low income and/or living with long-term illness/disability (Citizens Advice, 2017). However, these broad definitions may not reflect participants' subjective experience of what constitutes vulnerability (Groves et al., forthcoming).

A report for EAGA (Hodges et al., 2016) suggests that switching to a smart prepayment meter tariff could bring up to 181,000 UK households out of fuel poverty and reduce fuel poverty for others. However, the success of such a scheme may be contingent on other issues, such as trust in energy providers, since vulnerable consumers are amongst those least likely to switch (OFGEM, 2017b). Research has indicated that vulnerable consumers who have had a smart prepayment meter installed still face many of the same concerns as those with a traditional prepayment meter, with similar numbers self-disconnecting or expressing concern about keeping their meter topped up (OFGEM, 2018, Citizens Advice, 2018). With a financial cost to installing many smart technologies, there is potential to create an increasing social divide between those who can afford to purchase and install technology and those who cannot, as well as divides created by technical literacy. In a smart energy transition, those without access to the internet or smartphone could be excluded (Sovacool et al., 2019). Elderly tenants are of particular concern, given that they: tend to spend a greater amount of time inside their homes; utilize more domestic energy; 'may be on fixed incomes prone to fuel rationing

and need greater warmth with older age, and may also suffer physical limitations that inhibit their interaction with equipment’ (Sovacool et al., 2017:775; see also Barnicoat and Danson, 2015). However, it is important that a focus on elderly people does not result in overlooking the needs of other potentially vulnerable groups, such as those with disabilities and families with young children (Snell et al., 2018; OFGEM, 2018).

Many of the smart technologies currently on the market do not directly address the needs and wants of people who are in vulnerable positions, whilst the quick pace of technological advancements is creating big gaps in knowledge to the point that they are isolating large parts of the population. These gaps also make it more difficult for people to integrate ‘smart’ into their daily lives (Energy Saving Trust, 2015). Some aspects of smart technology, such as advanced automation and remote control, may be attractive to some but could alienate others (Darby, 2010). It is also relevant to consider occasions where lack of engagement with technology may be an active, rational choice i.e. if the financial outlay would not bring about sufficient benefits or if purported time-saving benefits of technologies are not required (Knowles and Hanson, 2018). Some work has been undertaken by the Energy Saving Trust (2011) to pilot smart technologies in fuel poor homes but subsequent changes to feed-in tariffs for renewable energy may have impacted the wider viability of such schemes. Exploring how people engage with smart technology in everyday life, or choose not to, therefore has an important role to play in this arena, given the ‘high stakes’ placed on smart homes and their associated technologies (Strengers, 2016:61). In this paper we explore vulnerable consumers’ perceptions and experiences of some aspects of smart technology in order to elucidate these issues and highlight implications for policy.

2. Methods and case site

We draw on data collected as part of the social science element of the Flexible Integrated Energy Systems (FLEXIS) project. FLEXIS is an interdisciplinary research programme, which integrates social science and technical research to address issues concerning the

energy system of the future, with a particular focus on Wales. As part of our work we are undertaking qualitative longitudinal interviews with residents in an ex-mining community; Caerau in the South Wales Valleys. Work is currently being undertaken in Caerau to explore the potential for a community district heating scheme using heat from water in disused mine workings. As part of this scheme, there is potential for residents to have a smart home management system installed in their homes for controlling heating in their individual properties. In the context of a broader focus on energy and everyday life, our interviews involved discussion of the proposed mine water project, including the smart heating controls.

24 residents aged from their early 20s to late 70s were interviewed in 2017. Participants were recruited through: leaflets delivered to all households in the area eligible to connect to the mine water system; contacts made at information events about the planned mine water scheme; social media advertisements and introductions through local gatekeepers. Sampling decisions were not based on any demographic criteria. The majority of participants owned their own homes but six rented privately and four occupied social housing. Eleven participants were unemployed, eight retired and five in employment. In line with definitions of vulnerability discussed earlier (section 1.2), 19 participants could be described as living in energy vulnerable households at the time of the first interviews. Whilst we did not ask participants for details of their income, some volunteered this information, and many spoke about the struggle of managing energy costs on a limited income. Participants were interviewed a second time one year later and on a third occasion after another 12-month interval, in an effort to explore how energy use might change over time, alongside development of the mine water heating scheme.

In initial interviews residents were asked about any experience that they had with smart technology, which often led to a participant-initiated discussion of smart meters as well as other technologies. In second and third interviews the topic of smart technology was raised again, initially following up on questions about smart meters (since some participants had had them installed between interviews). The meters that participants had monitored gas and electricity use, providing immediate feedback (i.e. turning red at

points of high electricity usage) and were used by participants to monitor daily or weekly consumption. In second interviews the researcher gave examples of other features of smart technology that may be included under the mine water heating scheme – such as control via mobile phone and automation of appliances – to elicit participants’ views on these features. In the third interview, participants were asked for their views on the suggestion that smart meters have the potential to help those in fuel poverty. Data were coded thematically using Nvivo qualitative data analysis software to identify data relating to smart. These data were interpreted in the context of the wider interview and other interviews with participants as part of the qualitative longitudinal dataset. In the following section we present insights from our data analysis in relation to three main themes arising from the preceding literature review: smart meters and affordability in relation to vulnerable consumers; age and the potential for smart technology to create or exacerbate divides; and issues of control.

3. Data Analysis

3.1 Smart meters and energy affordability

Whilst none of our participants explicitly identified as being in fuel poverty, some described restricting energy use (such as not using the central heating or oven) because of their financial situation. Managing rising energy bills on a limited income was something that many described, which led to increased awareness regarding how energy was used and paid for. Financial issues were therefore paramount in discussions of what new technologies might be able to offer consumers, suggesting that any smart technology would need to be able to demonstrate energy and financial savings to be fully embraced.

Prior to initial interviews, several participants had already had a smart meter installed by their utility company, with the expectation that it would help them to keep track of energy use and potentially make savings, and had varying degrees of enthusiasm about them. Others had smart meters installed over the course of our research, enabling us to see how the use of the meters changed over time. Some participants stated that they had made

changes to energy use in light of information provided by the smart meter; for example, replacing inefficient lighting, not overfilling the kettle, or changing their routines:

[Weekly] I look how much I've spent. And it's helped me that way, because if I think oh, I've spent a bit too much on gas now, I knock the heating off. Or I won't put the oven on until I'm ready to do a lot of things. ... It makes me do things slightly different. And I know exactly what I'm spending. So I find that a lot, big help. (Anne, 70s, I2)⁵

Others found smart meters to be useful or interesting information tools but they apparently had little impact on making changes to everyday routines and energy use. Interest in the smart meters often waned over the course of our interviews, as Serena (20s, I2) describes, '*I was completely unbothered by it. It didn't affect what I did with energy in the house at all.*', whilst Jenna (30s, I3) referred to the smart meter as '*really uninteresting*' and '*not really much of a motivation.*'

Most participants appeared to be very conscious of their energy use as they could not afford to be otherwise given their limited incomes. Therefore these participants saw little advantage to having a smart meter or other form of smart technology, as Terry outlines:

They do go on about this smart meter, but anybody with an ounce of common sense won't use anything they don't want to use. You know, and 'we can put it on your phone so it comes on when you come in from shopping'. Why? You can switch it on yourself. I don't understand this modern technology. They're brainwashing people ... I can turn it off when it's warm enough to turn it off, turn it on when it's cold, I'm the smart meter. I don't need something on the wall to tell me that. It's not going to save me money. Plus the fact you're being charged for the installation of it. That goes on your bill as well. They think, they think people are stupid ... Thick, dumb, I don't know, or, is it, they're spraying something in the air today? Because I'm a grown, I know how to do all that. You know, I won't let things run over time. I won't leave things on overnight. I roughly know the cost of it, and the ones I've seen, the needle's going up like that. All the time. So I don't want to be reminded how much I'm using. I'm quite good at cutting back. (Terry, 60s, I1)

5 All names used for participants throughout the paper are pseudonyms

Terry expresses scepticism that smart meters will offer any consumer benefit, using common antonyms for smart ('stupid', 'thick', 'dumb') to indicate that the technology is unnecessary, even wasteful, and will be costly for consumers. Instead he emphasises his ability to manage his energy use without technological intervention – in his assertion, 'I'm the smart meter' – and his experience in 'cutting back' given a limited income. In our discussions of smart, participants variously described themselves as 'luddite', 'dinosaur', 'simple' in explaining why they were not interested in, or felt unable to engage with smart technology. They used these descriptors apparently unselfconsciously, expressing that there was no need to be competent with what they regarded as unnecessary technologies. These terms contrast starkly with the way smart technology is often seen as synonymous with progress and cleverness (Gram-Hanssen and Darby, 2018), which risks positioning those who do not embrace it as backward looking or resistant to change. This view is problematic in positioning non-engagement with smart technology in terms of deficit, when it could actually be an active, meaningful and considered choice (Knowles and Hanson, 2018) based on life experiences. Our participants articulated a number of reasons for not engaging with smart meters. For example, Debbie had a smart meter installed just before interview 2. By interview 3 she was no longer using it, feeling it had not been able to tell her anything she didn't already know, saying *'I just felt really sad watching my money just go away. It was like I'd rather not see it, I'd rather just pay the bill'* (30s, I3). Similarly, and also echoing Terry's comments above, Len describes his reluctance to get a smart meter after hearing that it had made others 'paranoid' about their energy use (a phenomenon that has been discussed elsewhere, e.g. Hargreaves et al., 2010; Hodges et al., 2018).

So everybody I've asked who have got it, oh when they had it first 'great, oh I know exactly what I am using', and I find out that then they become paranoid about what they're using you know they run around the house looking for a light bulb on now, 'why am I burning that?' You know, so I don't know, I'll give that a miss at the moment as well, if you don't mind. (Len, 70s, I1)

However, by the second interview, Len had had a smart meter installed as part of a wider energy services trial that he had opted to participate in, yet his opinion showed little

change, describing the information provided as ‘no-brainer stuff’. By the third interview he had asked for the smart meter to be removed and was no longer participating in the trial as he had found it to be of no benefit.

In line with these comments, several participants expressed scepticism about claims that smart meters could help those in fuel poverty, because these consumers would already be acutely aware of their energy use and a smart meter would not address the underlying causes of fuel poverty.

[i]t’s not going to help somebody that can’t afford to buy it in the first place. If you haven’t got 10 pound to buy your electric, a smart meter’s neither here nor there. (Carole, 60s, I3)

The people in fuel poverty don’t need a smart meter to tell them they’re in fuel poverty, they know that. They need more money, you know, so what are we going to do, give them a meter? It’s, it’s just bollocks. (Jenna, 30s, I3)

Part of the reason that smart meters appeared to have little impact on energy use amongst our participants may have been that some energy-using practices, such as adjusting heating use to ensure those in ill-health are kept warm, are regarded as a non-negotiable necessity (e.g. Shirani et al., 2017, Sovacool et al., 2019, Brown and Markusson, 2019, see also Strengers, 2013 on other non-negotiable energy use). As a result, more information on cost would not necessarily lead to changes in energy consumption. Beyond physical comfort and health, some participants described the importance of energy use to their mental health, for example; using the television for company when living alone – “*I have the TV on all the time, and I sleep with the lights on.*” (Kim, 30s, I2). For people who were minimising energy use and managing on low incomes, a device that highlighted high consumption could be anxiety-inducing if it resulted from an activity that was regarded as essential or beyond the individual’s control (see also Hargreaves et al., 2010).

Several participants expressed reservations about having a device that purported to help save energy, but which actually consumed energy to operate (also Hargreaves et al.,

2013). During the second interview, by which time she had had a smart meter installed, Jessica voiced her frustrations with the in-home display; *“It's constantly needing a charge, so we just keep ours plugged in constant, because I find they're a nuisance if they're unplugged because the battery goes really quick.”* (Jessica, 20s, I2). This concern about cost raised questions about the trustworthiness and credentials of the smart meter scheme and other smart devices, particularly when promoted by energy companies, as participants saw this promotion of saving as contrary to energy companies' perceived aims of profit maximisation. Despite being told it would be a free installation, one participant described having to pay £140 to have her smart meter earthed, which impacted on anticipated financial savings. The ability of smart meters to address financial concerns therefore gave rise to a range of views, including scepticism that any savings could be made by those on limited incomes who were already necessarily careful about their energy use.

3.2 Age and engagement with smart technology

When it came to other forms of smart technology – such as the proposed home energy management system as part of the mine water heating scheme – financial concerns were less prominent. Instead, participants appeared to either show interest in the new technology, or regard it as ‘technology for technology’s sake’, implying an element of wastefulness. The under 40s were generally the most enthused, describing it as ‘cool’. Beyond perceived individual benefits such as greater control, some also saw it as a positive step forward in improving the community (as part of the wider scheme) through technological development. However, many of these participants expressed concern that smart technology would not be embraced by older residents. As Stacey comments:

[t]he older people live up there, not all of them have got these smart phones ... the younger people, it's beneficial for those ... It sounds a better system, isn't it, upping the times [laughter]. (Stacey, 30s, I1)

The older participants were generally less interested in smart technology, with Cheryl (in her 70s) describing it as *‘technology for the children.’* (I2). These quotes suggest the

potential for age divisions in the community along the lines of technological competence and confidence, as reflected in the literature review above, which could lead to variation in the uptake of smart technologies. Whilst age is not the only marker of difference in how people were perceived to engage with smart technologies, it was the most commonly commented on. Jenna expressed specific concerns about the use of smart technology in relation to the planned district heating scheme in Caerau (see section 2) because of perceptions of connectivity.

I think you'd really have to put some effort into combating the potential fear, for old people, older people, or people that aren't tech savvy ... Yeah, if we're all connected to the same thing, they might feel that, if they mess up their heating across the road, we're all going to freeze, or something. You know, I think there's potential there for people to get really scared of it. (Jenna, 30s, I1)

Jenna's comments echo findings in the existing literature that older adults can experience discomfort in using technology, describing it as 'frightening', lacking confidence in their ability to use it and fearing making mistakes (Knowles and Hanson, 2018). Our data indicate that whilst learning how to use smart technology might be intimidating for some people, the added complexity of being linked to a district heating scheme in which people might have the *perception* that their energy use could impact on others (although in reality smart heating controls would operate at the individual household level) could mean people are 'really scared' of the technology, potentially self-disconnecting or limiting their energy use. In light of UK government support for further development of heat networks, as well as expectations of further system interconnectivity (e.g. BEIS, 2018), these concerns are likely to become increasingly pertinent.

All residents appeared to presume that smart technology would involve complex control systems, with some people feeling confident in their ability to learn to operate them, whilst others were more uncertain. However, discussions of how people operated their current gas-fired central heating systems revealed that many people used an on/off switch on the boiler, operated manually, rather than programming timer settings or using thermostatic controls. Whilst, for some, these additional controls were simply not

available in their property, others preferred to have a simple on/off system. Some felt that this on/off operation gave them more control over their heating than a programmed timer because they could respond to daily variation. Strengers (2016) has indicated that householders often use complex thermostats as an on/off switch, arguing that, in this situation, a smart thermostat is no different from a 'dumb' one, being so complicated that its features are considered unusable. One elderly participant in our sample who had had a smart thermostat fitted between interviews found it too complex to use and had resorted to turning the boiler on and off directly to provide heating. Anne commented that the installer had not had time to show her how to use it and she had found the instruction manual unhelpful.

[Son] mucked it all up, he was going to put it off and on, and I said I'd rather knock it off upstairs and I know where I am, you know. No, he would, well, he buggered it up so much basically, that it wouldn't work at all ... [installer] said, "right, here's the booklet, read it!" I'm a bit thick, I think. It just doesn't sink in the problem is. I get so far with it and then I get a bit further and then I knock it all off again ... I thought, well I'm not really desperate, it's not that cold (Anne, 70s, I3)

Rather than contacting the installer for assistance, Anne was waiting for her next boiler servicing appointment to raise the issue. This example highlights the importance of tailoring technical support to individuals according to their needs, circumstances and competences, if smart technology is installed. It also raises questions about whether smart meters are necessarily appropriate for older adults (Brown and Markusson, 2019).

3.3 Smart control?

Participants who were enthusiastic about smart home control systems liked the idea of features such as being able to operate their heating remotely, so as not to experience uncomfortable variations in temperature. In this instance, smart technology was seen as potentially able to deliver greater control, convenience and comfort. However, others saw little practical benefit of a remote-control system to those who spent most of their time at home, suggesting such a system was designed with different lifestyles in mind. The

widely varying circumstances in which people live therefore mean that they are differently positioned in terms of need or desire for smart technology.

- PAUL: If people are working it would be good wouldn't it, because like, hour before you come home you can turn the heating on. In the winter. So you're not wasting, you haven't got to have it on all the time.
- DAWN: We're usually in the house, so it don't make a difference to us, it wouldn't, for that side of it like (40s, I1)

The idea of providing greater 'control' has been promoted as a selling point for householders. Yet, as noted in the earlier literature discussion, there is potential for smart technology to redistribute control within households (Gram-Hanssen and Darby, 2018) or reinforce existing control dynamics (Hargreaves et al., 2015). Moreover, the constant monitoring of how different people use the home could also be seen as oppressive and regulatory. For example, one participant commented that getting a smart meter would enable her partner to check up on her energy use.

I think for me as well it would be interesting to see how much I am using throughout the day because Mark is not here at all but at the same time I wouldn't want him to know how much I use during the day. (Serena, 20s, I1)

Whilst often discussed in jovial terms, the potential for surveillance of different household members' energy use raises important questions in relation to the broader issue of control as relational; i.e. who is in control within a relationship, and how this status may affect the control situations within families (Hansen and Hauge, 2017). This highlights the importance of accounting for control as a multi-dimensional construct that emerges from inter-relations between users, smart home technologies and domestic life (Hargreaves et al., 2016).

Beyond varying use of, and competence with, technology, practical issues were raised. For example, some participants were apprehensive about potentially increasing reliance on smart phones, particularly if their current phones were not compatible with more

complex technology – “*My phone won’t handle that, I’ve got an old brick.*” (Amanda, 30s, I2) – or if they preferred not to carry a phone with them regularly. Others raised practical concerns related to the location of their community, in particular, poor broadband or mobile phone connection. Again this highlights potential divisions that could be exacerbated by increased reliance on technology.

Well up here you don’t get a very good signal anyway, in the valleys ... I live in a house with stone walls and the mobile signals are not very good... I think the mobile signals would have to change drastically for it to work ... I think modern technology has got to move, I think, closer so that everybody can actually use the same equipment and ... that’s not going to happen for maybe decades that people living in rural spots, they don’t get the same benefits as people living in the town, yeah I think I would be a bit, not apprehensive, but I think I would be hoping that I could use the facilities if I actually signed up for that scheme, (Angela, 40s, I1)

Here Angela raises concerns about the ability of technology to deliver what is pledged, given there are practical barriers to doing so in particular places. These comments illustrate how the promises of a technological future are interpreted by people in the present through their knowledge of social practices, social relationships and place. The concerns that arise for people regarding the implementation of smart technology and about the plausibility of promised benefits could shed light on key aspects of the broader energy transition.

Thus far, this paper has focused on many of the residents’ concerns about the potential introduction of smart technology, particularly based on their experience with smart meters. However, some were more positive. For example, Kim stated “*I love my smart meter.*” (30s, I2) even though she thought her energy use had increased since having it. Pamela (50s, I2) was an early adopter, describing how “*we were there like a shot*” when smart meter technology was first available. However, as one of the more technically literate and financially comfortable in our sample, she did not necessarily share the same concerns as other participants. A small number had chosen to install some smart devices

themselves, such as smart thermostats, which were generally regarded positively. Others like Doug and Joan had opted for devices such as the Amazon Alexa:

I'm just learning at the moment but the future is to have everything controllable without getting out of my settee, just because I love gadgets and I just oh I love it, that's the best thing I've ever bought that is. (Doug, 60s, I1)

Much of their interest related to the ability to find information quickly and to control appliances (such as lighting) from one place, as well as Doug's enjoyment of gadgets. Despite this enthusiasm, by the second interview it was less frequently used as "*the novelty's worn off a little bit*" (Doug, 60s, I2), a sentiment that other participants also expressed. However, Joan's ill-health was seen as necessitating some features of smart technology. For example, remote light control had become increasingly important following Joan having a fall, which led to more restrictions of her already limited mobility.

The couple had also chosen to install a smart thermostat that sent them regular reports about their heating and enabled them to control it remotely to facilitate reliably comfortable temperatures. Doug expressed enthusiasm for how 'handy' it was 'to have so much control over the temperatures now of the house'. This control was regarded as beneficial, given how the couple emphasised the importance of warmth in relation to health (see also Shirani et al., 2017). Therefore, despite having a limited income, reducing heating costs was not seen as feasible and the smart technology was seen as helping to control rather than reduce energy use.

Some participants objected to smart technology as creating 'laziness' and were not interested in remote operating features, which they felt could potentially create health problems by encouraging people to be more sedentary. Yet they saw the potential value for other vulnerable consumers.

I suppose for people who are disabled and things like that it would be a hell of an advantage, because if people aren't able to do things like that it

gives them that little bit of thing to do it themselves ... for disabled people who can't get out of bed or are not mobile I think it would be a big advantage to them. To myself, I don't care, I'll get up and turn the light on. (Jessica, 20s, I2)

From our interviews, it appeared that, overall, participants had few expectations that smart technology would make much difference to their financial situations, given that those on low incomes already have to develop adaptive capabilities for managing and planning energy expenditure, keeping careful track of energy consumption because of concerns about affordability (Groves et al., forthcoming). Examples indicate possible benefits for vulnerable consumers living with enduring health conditions, an experience pertinent to several in our sample. At the same time, beyond predominantly first-generation smart meters, much smart technology is currently only available to those who can afford to invest in it, therefore may be unlikely to impact vulnerable consumers.

4. Discussion

Our research shows how, for people managing on low incomes, being conscious of energy use and ways of cutting back are already an established part of everyday life that new information provision is seen as unlikely to affect. In particular, by describing themselves using terms such as 'luddite', 'dinosaur' and 'simple' in an uncritical way, participants signalled their ability to live without what they saw as unnecessary, over-complex and even wasteful technology. Our interviews indicate that scepticism remains about the ability of such technologies to realise in practice the promises of 'smartness', which has implications for wider uptake. We have illustrated how such views were grounded in particular kinds of material circumstances, social situations, and lived experiences and are not based purely on financial concerns. This approach is informed by our previous work, which explores how agency is biographically patterned and how this 'patterning' is a product of attachment relationships and strategies for dealing with uncertainty (Groves et al., 2016). Such scepticism should not be dismissed as resistance to change or progress, but recognised as founded in valid concerns about the potential impact that a wider rollout of smart technology could have on the everyday lives of

vulnerable consumers. These concerns call into question the perceived inevitability of the smart energy transition, which has implications for the wider smart meter rollout and related policy in this area.

Within our dataset, concerns were evident about how feelings of confidence and competence in using smart technology have the potential to exacerbate existing generational divides, highlighting the possible isolation of older consumers as an important issue. Yet our participants saw the potential benefit of smart technology for other vulnerable energy consumers, for example with remote-controlled heating assisting those with mobility problems. This issue is important to consider given recent contentions that the focus on elderly consumers has led to other vulnerable groups – such as those with disabilities and long-term health conditions – being overlooked in relation to fair access to energy services (Snell et al., 2018).

Our work calls some of the promises of smart technology into question. Greater control for the householder makes some assumption of homogeneity of competences, yet there may be disagreements within households about energy use. There needs to be further consideration of the more relational aspects of ‘control’ in terms of the impact of technologies that allow household members to monitor and regulate one another’s energy use, with reflection on the potential power imbalances this could create or exacerbate. In terms of convenience, those who spend most of their time at home and use a simple on/off switch to control their heating according to sensed comfort are unlikely to see the benefit of a more complex system that enables remote control. This finding highlights how some smart technology appears to be designed with particular consumers in mind and it could be difficult to translate anticipated benefits to other groups, such as vulnerable consumers.

5. Conclusion and Policy Implications

Strengers (2016) suggests that smart home visions have been presented as a fait accompli, which is upheld by policy goals. Yet, it appears that little attention has been paid to the

varying circumstances in which people live and engage with smart technology. In this paper we have made efforts to generate insights from closely studying claims, perceptions and experiences of smart technology in the context of the lived experiences of low-income householders, with implications for related policy. We take the step of considering how fuel poor or vulnerable households might relate to the smart transition, given that they have explicitly been described as potential beneficiaries. In doing this we take forward the exploration of what domestic smart technologies are ultimately for (Darby, 2017). As Strengers (2013) argues, these snippets of everyday life reveal important transformative potentialities that are excluded from current aspirations for a smart world.

Our research suggests that assumptions underlying policy that smart meters will make consumers better informed about their energy use and thus promote better choices, need to be further considered. Many of our participants described being acutely aware of their energy use out of necessity due to limited finances. Assertions that energy providers could use technology to tell them something that they did not already know, or as a token gesture to addressing energy vulnerability, were met with scepticism or even deemed offensive, which led to resistance. Further, the promotion of an energy-consuming device as a route to purportedly save energy was met with suspicion. Our work suggests that there is scope for policy to further engage with these issues if vulnerable consumers are to feel that their concerns are being heard.

We suggest it is important for policy makers to reflect on whether purported benefits of smart technologies are relevant to vulnerable consumers, by considering legitimate reasons why people could be resistant to their adoption. Previous studies have highlighted potential ‘threats’ of energy system decarbonisation for vulnerable consumers (e.g. Sovacool et al., 2019), which could lead to worsening situations. We expand on these concerns in relation to smart technology, suggesting the importance of questioning whether moves towards smart represent improvement and progress across all social groups. Instead, we highlight the need to consider how it may impact people differently as crucial in ensuring that the situation of vulnerable consumers is not worsened. Transition to increasingly smart systems risks exacerbating divides along the lines of technical confidence and competence, as well as desire and opportunity to engage with innovation. Care must be taken in implementation to ensure that social exclusion does not happen by default, with older people at particular risk. Our work in this area has been applied in a policy context to illustrate ‘no one left behind’ as an important theme in smart energy system transition, highlighting the significance of social inclusion (Welsh Government Smart Living Initiative, 2019). If wider rollout of smart devices were to be successful, our research suggests that more effort needs to be made to demonstrate how purported benefits of smart technology can be realised for vulnerable consumers, which requires greater understanding of how vulnerable consumers currently manage their energy use.

As we have sought to illustrate in our discussion of ‘control’, the technologies themselves are not neutral but can serve to reconstitute the fabric of everyday life (Strengers, 2016)

in both useful and, crucially, unhelpful ways. Our analysis indicates that more efforts are needed to consider how energy system transitions can be nuanced and attentive to the varied circumstances of people's lives, including relationships and dynamics of control. We have highlighted how it can be important to recognise resistance to smart technology as an active choice based on individual circumstances. Many of our participants indicated that they saw smart technology as irrelevant to their everyday lives, or designed with different groups of people in mind, and failed to see how it could provide purported benefits. By taking a qualitative longitudinal approach, we have been able to elucidate how people's relationships to smart technologies change over time. The apparent waning enthusiasm for smart technologies raises challenges for the perceived inevitability of the smart energy transition, particularly the planned national rollout of smart meters. Our analysis therefore supports existing calls to think more broadly about the role and place of feedback in wider energy transitions (Hargreaves, 2018). We argue that this consideration is particularly pertinent in relation to vulnerable consumers to avoid creating further disadvantage. In light of concerns regarding the potential isolation of large parts of the population through rapid technological advancement (Energy Saving Trust, 2015), our research has importance in elucidating the perspectives of those who have the potential to be left behind. We therefore argue for the importance of further work in this vein to critically consider the transition towards smart energy technologies.

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